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Method to the determining the number that

Particle within a volume of air and apparatus for the execution of driving The invention relates to a method to the determining the number of the particles, in particular dust particle, within a volume of air for the examination of the degree of purity of the volume of air bottom application of centrifugal separation of the particles aiis a diverted measuring air flow, bottom simultaneous application ζ s of electric field; besides the identification concerns an apparatus to the carrying out the method.

In the range of the sanitary engineering, hospitals, pharmacies, pharmaceutical factories, in addition, in other ranges of the technique, for the example of the semiconductor manufacture, increasingly dust free spaces and chambers required become. In particular it is prescribed after the medicament law that must be ensured with the preparation of prescriptions the fuse of the microbiological quality of the drugs. In addition it requires corresponding apparatuses, which are suitable to hold microbial contamination during the preparation of the products remote. That can become by the fact achieved that within the working range an highly purified air flow away-flies over the working range continuous, which flows off over the entire cross section of a defined range with if possible uniform speed and almost parallel streamlines. The critical effect regarding the degree of purity of the ambient volume of air is the rapid evacuation by working process, - devices, person movements o.a. set free particulate impurities.

The problem arises, the effectiveness of the used dust extracting installations to examine filters and such a thing.

This is done via certain mechanisms, which permit it, the number of the particles to determine in particular the dust particle of a volume of air.

The determination of the number of the dust particle now dust measuring instruments known became, those the scattering of a light beam, the example of a laser beam, at the dust particles use, in order to head for electrical light measuring instrument and a counter, so that can become direct counted in a certain arrangement of the air circulation the number of the dust particles. Such mechanisms are expensive, in sequence of the use of lasers and eventual expensive extraordinary of photomultipliers and. But they determine the sought number of the dust particles with nearly arbitrary accuracy. For the needs of the practice it does not arrive now on this accuracy of the measurement value necessarily in all cases.

Among the payment of the dust particle it furthermore known are to rank the same bottom use of a microscope primarily with Dunkelfeldkondensor. While the electrical payment somewhat higher effort a conditional, which in a higher accuracy is then again-reflected, are the optical counting procedures the bottom microscope with particular Counting ranking, among the example with the erythrocyte counting, each physician and each pharmacist known.

In the Dunkelfeld of a microscope now the same dust particles are more visible in accordance with the principle of the optical diffraction, as they become displayed of the known laser metre. Also here the particle size is only downward limited by the light wavelength, because can be quite done with the payment without a form-faithful image of the particles (so called Ultramikroskopie).

To the deposition of the dust particle from an air flow two other electrostatic precipitation procedures are known beside filters. On the one hand the air in swirling current can become offset, so that in it contained particles by it Centrifugal forces at the walls of the vessel, einVeogenannten Cyclone-deposited and thus from the air remote becomes.

|Andererseits are electrical dust sampler-known, becomes generated with which at an electrode, for the example a thin wire, a very strong inhomogeneous electric field, so that becomes applied on the particles by the dielectric polarization a force, which drives the particles to the wire and separates the same there. Furthermore it is known to charge the particles additional by corona discharge elek trisch and to drive to it the bottom effect one elektrischen field to an electrode, where the particles become deposited and counted to become to be able.

The object is appropriate for the invention to reasons to create a method of the genus initially specified which it allowed) the number of the particles within a volume of air inexpensive and bottom possible utilization from apparatuses present in each medical or pharmaceutical equipment to to determine, whereby the method simple should be manageable feasible and the apparatus for this simple) bottom reaching of a sufficient high accuracy.

The solution of this object exists to be caught therein that ~an in the range V deflection of the measuring air flow becomes according to invention an electric field generated, its field lines in the range within the electric field of a target approximate vertical been because of the edge of the current of the measuring air flow to the streamlines of the current run, whereby the field lines lead the particles, which if necessary before electrical charged are, by the boundary layer of the current through to the target, by cathedral the particles, according to which the same counted optical electrical in ansch Wkanter manner or become.

In embodiment according to invention the measuring air flow can become a circular path with very small radius forced in the range elek of the trischen field the generation of the deflection, or it can become a Couette or a shear flow or a vortex flow generated. Besides the electric field can become also to the target placed, whereby the target and this adjacent electrode on same potential lie. Preferably a strong inhomogeneous electric field becomes the generated apparatus according to invention possesses the conspicuous advantage that certain with it the number of particles can become within a certain volume of air also for many ranges of the practice of sufficient accuracy. The method is not simple and safe and required acidic ones and expensive apparatuses.

An apparatus for the execution of the invention process is characterized by guide means for returning and leading the measuring air flow, which are between two disposed troden in distance from each other befindlichai Hochspannungselektrode, to which an electric field placed is, in which in direct neighbourhood to an electrode a target disposed are. Those the target direct adjacent electrode can preferably be a peak electrode.

By the centrifugal forces arising within the deflection of the current the dust particles at the outside become Edge of the current urged, accurate stated, into the vicinity of the boundary layer of the current, which adheres as practical resting layer at resting walls, in particular thus at the target. For a given flow rate v thereby the radius of curvature of a streamline of the current EO small must be as possible, because the centrifugal force EMI11.1

reverse is the proportional radius of curvature R. If for example $v = 1 \text{ m/sec}$ is and $r = 1 \text{ mm}$, EO centrifugal acceleration in such a current heiDt, too subject of acceleration due to gravity. A comparable Zentrifugalbesohleunigung can be obtained in laboratory centrifuges with 1000 to 1500 Upm.

Now the particles become according to invention by the resting boundary layer through on the target transported by an approximate vertical electric field acting to the streamlines. The arrangement can be so met that either the electric field becomes main strong inhomogeneous made by a peak electrode at the target, so that also uncharged particles become transported by the dielectric Polarisierung on the target, or however the particles can top become electrical charged before the catching arrangement by a corona discharge taking place in the air flow. The target can be a metal plate or a

metal wire, if the particles electrical counted to become to be supposed. In addition the target can serve simultaneous as electrode, in order to produce the electric field. This metal electrode is then over amplifiers on anisich known counting means and evaluation devices for pulses, as for example microprocessors, angeschlos sen.

For the optical counting the particle can be the target a plate from transparent material, preferably polished glass, which becomes with a sticky, likewise transparent liquid so prepared that to the target remain clinging to transported particles there. The guide means consist of insulating material. The sticky liquid is in its vapor pressure so adjusted that it does not evaporate during the measuring procedure in considerable extent, like that D a certain - to beginning of attempt applying volume of liquid after the known methods to the optical payment of particles in certain volumes by means of a microscope other processed will can.

All boundary conditions of the experiment such as starch of the air flow, starch of the electric field, period of the measuring procedure, become constant held, so that a certain amount of particles hitting the target corresponds to a certain percentage of all particles in the measuring air flow, which by calibration curves detected becomes. These calibration curves can become also main the example with the electrical payment by appropriate programming of a microprocessor introduced, which is connected with the counting device. From suitable, anisich known indicating and recording devices then immediate that can be read off dust content of measuring air in particles per m³.

In other, embodiment according to invention a hemispherical shell becomes from insulating material used, which exhibits an hole at its deepest site and which is on the plate shaped target fitted, of the bottom in the range hole the peak electrode is the generation of a radial air flow as guide means, whereby is placed on the target within the hole a drop of a sticky liquid.

Besides a Metallplättchen can be as targets disposed, the bottom which peak electrode is using the hemispherical shell from insulating material within the hole, whereby the metal panel is placed on the potential of the peak electrode, preferably over an high ohm resistance, whereby is connected to the metal panel an electrical counter.

Besides a Couette or a shear flow generated can become, those most simply by two concentric cylinders the deflection of the air flow, from which a rotated, generated becomes. Isem case the guidance mechanism consists according to invention of a cylindrical housing with and a diverting opening, is rotatable eccentric disposed in which a rotor, which forms the simultaneous one electrode, whereby in the range of the smallest distance A of the housing opposite the plate shaped target is appropriate for the rotor, bottom that the peak electrode disposed is.

In other, embodiment according to invention two plates can be flat-parallel on the plate shaped target disposed from each other vertical in the distance for the generation of a Couette or shear flow, whereby central between the plates is and lengthwise disposed to the same rotatable, simultaneous as electrode serving cylinders, whose distance is smaller b to the target, than to the plates and over that flat-parallel is to the plates a separation plate disposed, whereby is disposed underneath the target the peak electrode.

In other embodiment of the apparatus according to invention Führungsein direction can be a turbine to the generation of an eddy air flow, opposed disposed at whose output the two high voltage electrodes are, whereby above the peak electrode of the targets placed is.

The invention is in the subsequent description more near explained on the basis in the drawing of represented embodiments. Show: Fig 1 a schematic view of according to invention

Apparatus, whereby the guide means are an half one socket pad and are on the target a droplet of a sticky liquid placed, fig 2 a view of an other example with an half one socket pad as guide means, whereby within the deepest point the same metal flat marriages as target a disposed is, fig 3 an apparatus to the generation of a Couette current, fig 4 an other apparatus in perspective view to the generation of a Couette current and a fig 5 a turbine to the generation of an eddy air flow, which becomes performed after exit between the two electrodes.

In accordance with the fig 1 the air becomes 1 removed over a Ennahmetrichter, whereby by means of a blower two a measuring air flow generated becomes. This measuring air flow becomes 4 performed over a nozzle 3 by a plate shaped electrode, which is 5 connected with an high voltage source. The nozzle 3 is structural combined with the plate shaped electrode.

Opposite the electrode 4 a target is 6 disposed in the distance, which is in this example likewise plate shaped formed and consists of transparent material, preferably glass. On the target 6 is a droplet 7 of a sticky liquid placed. Underneath the target 6, direct below the drop 7 is the second electrode, which is preferably 8 performed as peak electrode, which is 5 connected with the other pole of the high voltage source.

Over the droplet 7 now guide means are 9 fitted, which consist here of a hemispherical shell with spherical wall lo. The hemispherical shell 9 possesses an hole 42, which direct over the droplet 7 is inverted at its deepest point. Furthermore the hemispherical shell 9 consists of insulating material. The hemispherical shell 9 leads the air flow in such a manner that the streamlines of the current in that Vicinity of the droplet 7 strong curved will, in order to produce so as large a centrifugal forces as possible. The inhomogeneous electric field strong generated by the electrodes 4 and 8 in the vicinity of the electrode 8, then vertical and the transported particles, which by the centrifugal forces to the edge of the current urged are, stand by the quasi resting boundary layer through into the droplet on the streamlines.

A motor 13 to the drive of the blower 2 and the high voltage source 5 are 12 in such a manner connected that the entire mechanism can become a defined time prolonged, over a time switch clock 11 and a relay, about 5 minutes, the bottom conditions in operation held, defined by the arrangement.

The measuring procedure with this apparatus designed itself as follows: a slide, for instance the lid of a microscopic counting chamber, becomes inserted as targets 6 into the apparatus. With a Mikropquette becomes a drop of a special liquid, which exhibits a vapor pressure, which corresponds to that measuring air, on the target 6 accurate opposite the nozzle 3 applied. The hemispherical shell 9 inverted over the drop 7, then becomes the time switch clock 11 on a certain value adjusted and the motor 13 started.

Thus an air flow in becomes generated by the arrow in fig 1 the direction indicated, which becomes direct diverted there moved in the direction of the droplet strong 7 and.

After shutdown of the apparatus the target 6 on a microscopic counting chamber fitted is counted out there and in known manner.

Fig 2 shows an other embodiment using the hemispherical shell 9 of the fig 1. The target is as small a metal panel as possible 14, which lies to the avoidance of estimates if possible on the potential of the peak electrode 8, preferably however here with this connected is only high impedance. The metal panel 14 is direct within the hole 42 of the guidance half shell 9 disposed; over RC elements 15 the metal panel is 14 to an amplifier 16 and a counter 17 and eventual other processing means, like microprocessors, connected.

The remaining structure of the apparatus corresponds to that in fig 1.

An other example of an apparatus according to invention to the carrying out the method is in fig 3 shown, whereby the deflection of the air flow a Couette or a shear flow becomes generated here. The guide means consist of a cylindrical housing 19, is 18 rotatably disposed in which a rotor. The housing 19 exhibits a supply port 21 and an exhausting opening 22 for the air flow. The rotor 18 is within the housing 19 eccentric disposed, ge towards over the target 25, which is here plate or disc shaped formed. Beyond the target 25 again the peak electrode is 8 disposed; furthermore as the second electrode the rotor serves 18. Das housing 19 is by a partition 24 into two parts geteilt1 so that the eventual rotor 18 an air flow occupied with paddles by Zuführund exhausting openings through by the gap 23 between the rotor and the housing 19 past at the target 25 generated.

With rotation of the rotor 18 a flow field and an electric field within the gap 23 in the range of the smallest distance A of the rotor 18 from the target 25, whose field lines approximate vertical stand one on the other, develop. The Par tiket is driven thereby on the target 25, where her the analogue embodiment of the figs 1 and 2 counted to become to be able.

Fig 4 points an other embodiment to the generation of a Couette current. On a target 30, which is plattenförmig formed here, two plates are 26, 27 flat-parallel to each other disposed, whereby the plates can be in the bottom portion in the vicinity of the target 30 curved formed. Above the target 30 and between the plates 26, 27 is along a cylinder 29 disposed, also can. genalxert una antrelouar V of the cylinders Z9 sit & a distance b of the target 30, which is smaller, than the distance is from diskabow the cylinder the 29, likewise flat-parallel to the plates 26, 27, a separation plate 28 disposed. Underneath the target 30 is the peak electrode 6. The air flow becomes now toward the arrow 31 into the arrangement introduced, rotates the cylinder 29 between the target 30 and the cylinder through and escapes toward the arrow 32 between the separation plate 28 and the plate 26. The radius of the cylinder 29 forms then the smallest radius of curvature for the air flow. The separation plate 28 with the cylinder 29 form the second electrode. The top remaining arrangement corresponds in fig to the 1. With this arrangement not as strong inhomogeneous electric fields can be produced, as with the aforementioned arrangements with given voltage between the electrodes, however the effect of the centrifugal force strong can be increased an other

embodiment for the execution of the invention process is in fig 5 shown. In this arrangement the guide means consist of a turbine 33, with which thus the blower and the switching off mechanism are constructive combined, as also in the embodiment in accordance with fig the 3 is the case. The turbine 33 possesses a turbine wheel 34, whereby the head of the turbine wheel is provided with a streamlined fairing 36. The turbine wheel 34 is in a tube disposed, which exists out swellparallel pieces of 37 and 39, as well as from a nozzle 35 and one Diffuser 38. In the nozzle 35 inclined/slanted vanes are where disposed, which return the air flow propelled by the turbine wheel if possible into tangential direction of the nozzle 35. By the set of the maintenance of the angular momentum then the air flow receives a very high tangential velocity, which exercises large centrifugal forces on the particles to other stream with its by the nozzle 35. In the parallel tube piece 37, which in this arrangement with square cross section performed is main, are the target 6, the peak electrode 8 and the counter electrode 4 disposed, whereby the applied electric field the particles again according to invention by the boundary layer of the now eddyful current on the target 6 transported. Subsequent one escapes the air by a diffuser 38, whose sense is it to reduce the flow resistance of the overall arrangement.